Integrative detection of Human, Object movement and Fire Sensing Using LoRaWAN Gateway

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Received 15 June 2019 Received in revised form 19 June 2019 Accepted 21 June 2019
Available online 28 June 2019

Abstract **- Our future battle field system will have more difficulties to maintain security, because of increasing military competitive. Ability to understand, predict and adopt the vast array of inter-networked things is very difficult. Unwanted fire, unauthorized human intervention and other object movement will play major important role for affecting military environment. This project aims to help our future military environment by introducing new technology LoRaWAN in IoT (Internet of Things). LoRaWAN (Long Range Wide Area Network) is a state -of- art commercial of the self (COTS) technology. This project consist of sensors, embedded microcontrollers equipped with LoRaWAN, embedded processors equipped with LoRaWAN and cloud technology. By introducing this new technology in our future military environment we can easily find out criminal activities and fire hazards.**

Keywords *— Military environment monitoring, Cloud system and COTS Technology, LoRaWAN gateway.*

I. INTRODUCTION

Low Power Wide Area Networks (LPWAN) networks are recently emerging as an effective approach for IoT, and it

provides connectivity to various sensors and actuators. The key objectives for LPWAN is to provide scalability, extended coverage, low cost, and energy efficiency for end user devices. This is contrary to conventional cellular networks, which are focused on providing high data rates and low latency.

Currently, the proposed implementation for IoT can be categorized into using commercial bands and ISM bands. Within the commercial band, the existing GSM/GPRS cellular infrastructure provides low cost and good coverage. Recently Narrow Band IoT (NB-IoT) network based on the LTE standard is introduced as alternative solution to GSM/GPRS. With the aim to offer IoT connectivity in a 200 kHz spectrum.

On the other hand, the license free Industrial, Scientific, and Medical (ISM) band can be used by anyone, but this band is subject to internal and external

Interference, contrary to the licensed cellular spectrum utilized by GPRS and NB IoT,

LoRaWAN have following features:

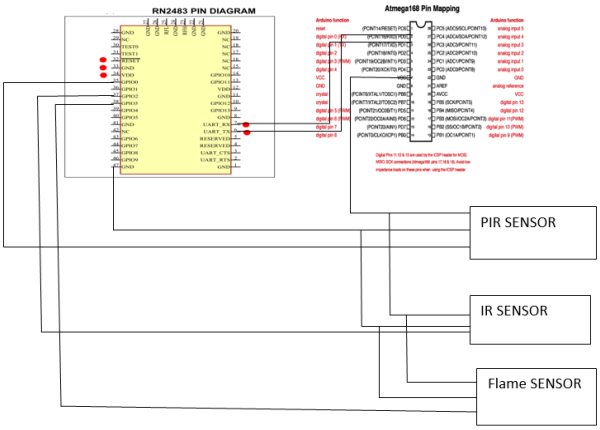
1. The range of LoRaWAN:
   i). An urban environment - up to 2 to 5 km
   ii). The rural areas - 5 to 10 km
2. LoRa's frequency range depends on "radio line-of-sight." Radio waves in the range of 400 to 900 MHz
3. One of the best features of LoRaWAN is long battery life. To achive the long battery life devices are designed to go deep sleep mode, when not transmitting messages.
4. Another one important features of LoRaWAN is localization. It is done by without the need of GPS. Since this setup is fully battery-efficient
5. In a short span of three years, many companies and organizations have become part of the LoRa Alliance.

Cloud system having following features:

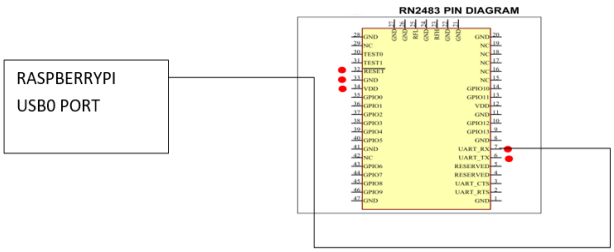
1. Security
2. Automatic Updates on software
3. Enhanced collaboration
4. Easily manageable

II. CIRCUIT DIAGRAM

A. TRANSFER MODULE



B. RECEIVER MODULE



III. COMPONENTS USED

SOFTWARE

A) ARDUINO IDE

Arduino IDE is a kind of software. It is used to inhibit the programs into the microcontrollers from the personal computers. Most of the microcontroller inputs are in C & C++ programming language format. Instruction is given to the micro controller in code format. Our project C language is used for coding.

B) PROTEUS CIRCUIT DESIGNER

Proteus is an Electronic Design Automation tool it also includes simulation and PCB Layout modules. It is a Windows application for schematic capture, simulation, and PCB layout design purpose. Produced simulation is depending on the size of the application. By using this circuit designer we can design products like auto router and basic mixed mode SPICE simulation capabilities.

C) EMBEDDED C LANGUAGE

Embedded C language is a kind of programming language. Set of Key extensions of general C language should be used here to overcome or solve the issues in the embedded system devices

D) MOBAX TERM SOFTWARE

MobaXTerm is a kind of software, it provides a remote network tool for windows. Instruction given to the processor by means of MobaXTerm software. It is a one of the main important software for remote computing. It contains all UNIX commands for windows. Here we give the instruction to the raspberry pi by using MobaxTerm.

E) EMBEDDED PYTHON LANGUAGE

Python is a high-level, general-purpose programming language. It plays major important role on embedded system. It supports following programming paradigms, including Impressive, object-oriented, functional and procedural. Python programming language is very simple compare to another programming languages

HARDWARE

F) ARDUINO ATMEGA- 168 MICROCONTROLLER

The high-performance, low-power AVR RISC-based CMOS microcontroller. It should combines the 16KB ISP flash memory with read-while-write capabilities. It is an 8 bit micro controller and it's having 512B EEPROM, 1KB SRAM. And it's also includes 23 general purpose I/O lines and 32 general purpose working registers.

The 10-bit ADC module attached to that device it plays vital important role on sensor interfacing. It contains 8 no of channels that channels are enough to provide analog to digital conversion.

AVR microcontroller contains following, three flexible timer/counters, serial programmable USART, internal and external interrupts.

Serial peripheral interface (SPI) is used to communicate between the microcontroller and other peripheral devices likes SD cards, shift registers, and sensors.

G) POWER SUPPLY

Power supply is also include in our hardware of the project Two kind of power supply we are using they are 5V and 12V. Interfacing devices will get the supply from main microcontroller.

H) PIR SENSOR

A passive infrared sensor (PIR) is an electronic sensor. It is used to measure infrared light radiation from the objects in field. PIR Sensor mostly used to detect the motion.

PIR sensors is used to detect the human movement in the sensors range. This sensors are small in size, inexpensive, low-power consumption, and its user friendly. For that reason they are commonly found in appliances and gadgets in businesses and home applications. They are often referred to as PIR, "Passive Infrared", "IR motion", or "Pyroelectric" sensors.

PIRs are made of a pyro electric sensor, In PIR sensor we can see the round metal as below and rectangular crystal in the center, which can detect levels of IR radiation. Everything emits radiation in the low level range, but Hotter and something it's emits high level radiation. PIR sensor is having following features

1. **Output:** i). High Digital Pulse is triggered - motion is detected ii) Low digital pulse is triggered - No motion is detected.
2. Resistors and capacitors on the PCB board are used to determine the Pulse lengths. It should differ from sensor to sensor.
3. **Sensitivity range:** Range up to 20 feet (6 meters) 110° x 70° detection range

I). IR SENSOR

An infrared sensor is kind of electronic sensor that emits IR radiation in order to sense some aspects of the surroundings. It is used to measure the heat of an object and motion of the object. These types of sensors measures only infrared radiation, so it is called as a passive IR sensor

In infrared spectrum, all the objects are radiate some form of thermal radiations. These types of radiations are invisible to human beings that can be detected by an infrared sensor. Here emitter is an IR LED (Infra Red Light Emitting Diode) and the detector is an IR photodiode, Emitted wave length of IR LED and sensing wave length of Photo diode are equal. Magnitude of the received IR light is proportional to the resistance and output voltage of the photo diode.

IR sensor circuit is one of the basic and popular module in our electronics, this one is analogous to human's visionary senses, it is used to detect obstacles and this one is a common applications in real time. IR sensor circuit having the following components

1. LM358 IC 2 IR transmitter & receiver pair
2. Resistors (Kilo Ohm range).
3. Variable resistors.
4. LED (Light Emitting Diode).

J) FIRE SENSOR

Fire sensors are the kind of the sensor. It is used to sensing fire/ Flash light. And also sensing the following like smoke, heat, infrared and ultraviolet light radiation.

Infrared or wideband infrared flame sensors, monitor the infrared spectral band for specific patterns. Specialized fire-fighting thermal imaging camera (TIC) is used for sensing the flame, this camera is a type of thermo graphic camera. If water is present in the lens surface of the camera, it will reduce the accuracy of the detector, and also it will exposure to direct sunlight.

A frequency range is 4.3 to 4.4 µm. This is a resonance frequency of CO_2. Large amount of heat and CO_2 released while burning the hydrocarbon (eg: wood or fossil fuels such as oil and natural gas). Large amount of energy emitted by hot CO_2 at its resonance frequency of 4.3 µm. This causes a peak radiation. The "cold" CO_2 in the air is taking care that the sunlight and other IR radiation is filtered. That one makes the sensor in this frequency "solar blind", due to sunlight sensitivity is reduced.

K) COMERCIAL OFF THE SHELF TECHNOLOGY

LoRaWAN is based on COTS (Commercial of the Shelf) technology. In this technology hardware and software components are available in ready madly for our technical applications

Commercial off-the-shelf or commercially available off-the-shelf (COTS) products are packaged solutions which are then adapted to satisfy the needs of the purchasing organization, rather than the commissioning of custom-made, or bespoke, solutions.

L) CLOUD COMPUTING

Cloud computing is used to storing and accessing the data's and programs on Internet instead of computer hardware. It is the metaphor for the internet.

Cloud computing should provide higher level of services with minimal management effort.

VI. WORKING

Our proposed system consist of two modules, one is transmitting module and another one is receiving module. Transmit side LoRaWAN equipped with microcontroller this module connect with sensors and collecting information from sensors. Receiving section LoRaWAN is equipped processor with cloud computing. Transmitting section collect information from sensors and it will communicate to the receiving section. By using cloud computing with LoRaWAN gateway .By means of internet we can easily monitoring sensing information everywhere in the world.

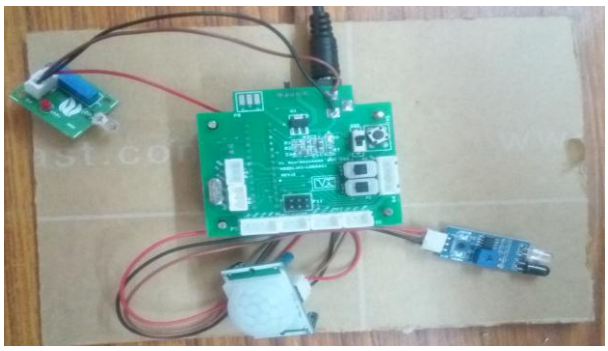


Fig: Transmitting section

Fig: Receiving section

V. RESULTS & DISCUSSION

We will first focus on increasing the density of gateways to measure their impact on the network performance, especially the overall coverage and frame duplications. We will also increase the number of end-devices to evaluate the maximum capacity per gateway. Finally, the packet loss may be of crucial. We will also take into consideration the performance of LoRaWAN confirmed uplink transmission. Our future plan is to build the LoRaWAN communication in long range with N number of sensing elements in long distance and monitoring it.

VI. SCOPE

In future, this system can be implemented industries, Educational institutions, and ever state borders for proper monitoring of criminal activities.

Further addition of sensors in transmitter module will increase the capturing information.

VII. CONCLUSION

Our future battle field system will have more difficulties to maintain security, because of increasing military competitive. Ability to understand, predict and adopt the vast array of inter-networked things is very difficult.

The proposed architecture utilizes LoRaWAN, the Long Range Wide Area Network that is power efficient and supports easy integration with COTS technology. The proposed architecture consists of sensors, embedded micro-controllers equipped with LoRaWAN compatible radios, processor equipped with LoRaWAN and cloud computing with LoRa gateway. Our contribution was twofold: first, our proposed architecture showed interoperability with tactical C2 systems; second, we evaluated the prototype implementation in order to better understand the compatibility with different vendors and to evaluate the performance in terms of communication range. The range test demonstrated that LoRa was able to operate at up to a distance of 6.1 miles in the semi mountainous terrain where it was deployed.

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